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SECTOR COMPETITIVENESS FRAMEWORKS

AIRCRAFT AND AIRCRAFT PARTS PART 1 – OVERVIEW AND PROSPECTS

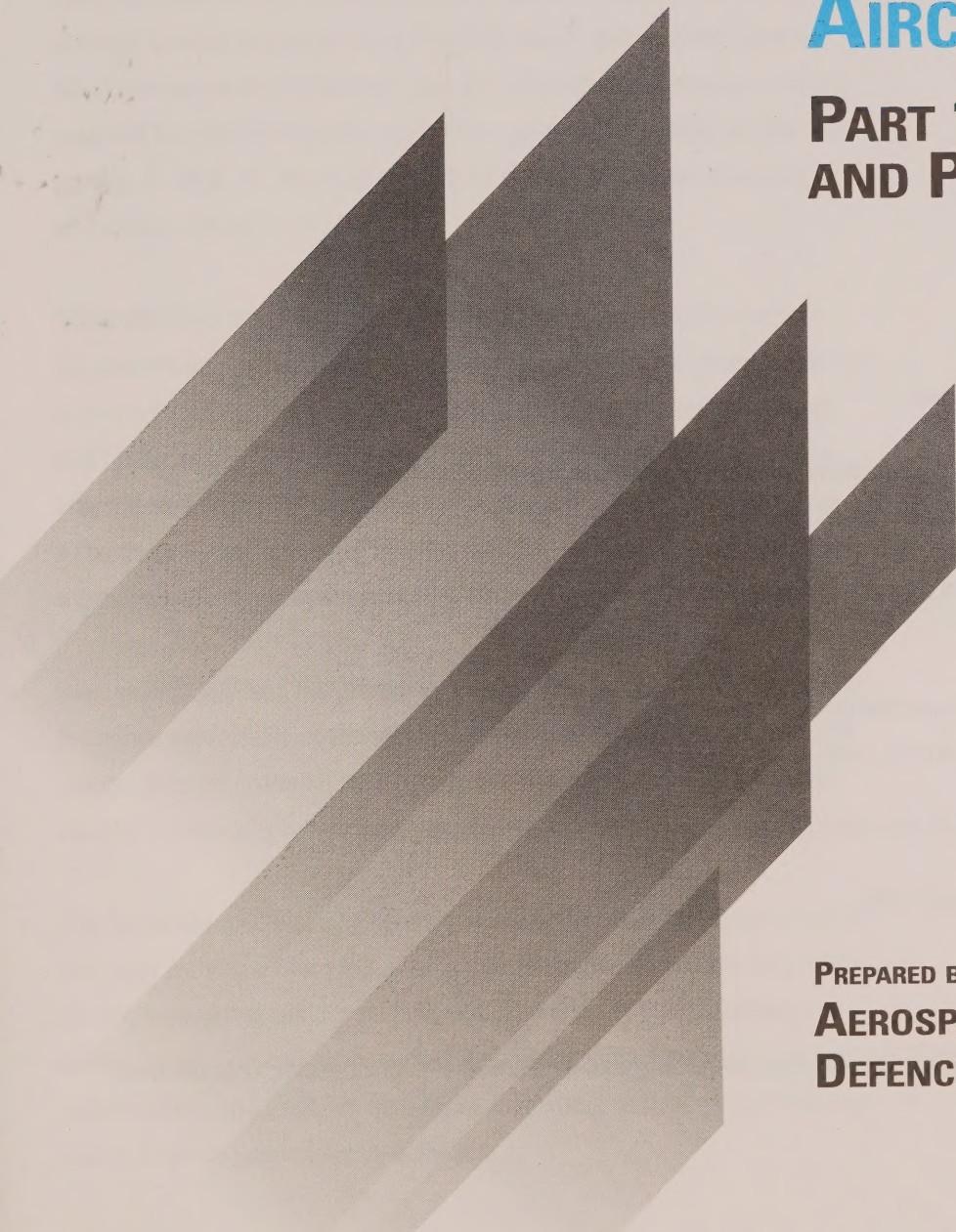


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AIRCRAFT AND AIRCRAFT PARTS

PART 1 – OVERVIEW AND PROSPECTS



PREPARED BY:
**AEROSPACE AND
DEFENCE BRANCH**

This *Overview and Prospects* is the first of two companion documents on Aircraft and Aircraft Parts in the **Sector Competitiveness Frameworks** series, which is being produced by Industry Canada in partnership with Canada's key stakeholders in the industry. *Part 2 — Framework for Action* will be prepared in coming months, based on consultations with major industry stakeholders, following study and review of the *Overview and Prospects*.

The **Sector Competitiveness Frameworks** series will focus on the opportunities, both domestic and international, as well as on the challenges facing each sector. The objective is to seek ways in which government and private industry together can strengthen Canada's competitiveness and, in doing so, generate jobs and growth.

In all, some 29 industrial sectors will be analyzed. *Part 1 — Overview and Prospects* will be available for distribution in printed as well as electronic forms during coming months for the following industries:

Aircraft and Aircraft Parts

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FOREWORD

The new Canadian marketplace is expanding from national to global horizons and its economic base is shifting increasingly from resources to knowledge. These trends are causing Canadian industries to readjust their business approaches, and government must respond with new tools to help them adapt and innovate. Industry Canada is moving forward with strategic information products and services in support of this industry reorientation. The goal is to aid the private sector in what it is best qualified to do — create jobs and growth.

Sector Competitiveness Frameworks are a series of studies published by Industry Canada to provide more focussed, timely and relevant expertise about businesses and industries. They identify sectors or subsectors having potential for increased exports and other opportunities leading to jobs and growth. In 1996–97, they will cover 29 of Canada's key manufacturing and service sectors.

While they deal with "nuts and bolts" issues affecting individual sectors, the Sector Competitiveness Frameworks also provide comprehensive analyses of policy issues cutting across all sectors. These issues include investment and financing, trade and export strategies, technological innovation and adaptation, human resources, the environment and sustainable development. A thorough understanding of how to capitalize on these issues is essential for a dynamic, job-creating economy.

Both government and the private sector must develop and perfect the ability to address competitive challenges and respond to opportunities. The Sector Competitiveness Frameworks illustrate how government and industry can commit to mutually beneficial goals and actions.

The Sector Competitiveness Frameworks are being published sequentially in two parts. An initial *Overview and Prospects* document profiles each sector in turn, examining trends and prospects. The follow-up *Framework for Action* draws upon consultations and input arising from industry-government collaboration, and identifies immediate to medium-term steps that both can take to improve sectoral competitiveness.



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CONTENTS

1 HIGHLIGHTS	1
1.1 Major Trends	5
1.2 The Bottom Line	9
2 KEY POINTS ABOUT THIS INDUSTRY	11
2.1 Global Context	11
2.2 Canadian Industry Snapshot	20
2.3 Performance and Competitiveness	26
3 CHANGING CONDITIONS AND INDUSTRY RESPONSE	37
3.1 Changing Global Conditions	37
3.2 The Industry's Response	41
4 GROWTH PROSPECTS	48
4.1 Strengths and Weaknesses	48
4.2 Key Issues	52
REFERENCE MATERIALS	56

Aircraft and aircraft parts manufacture is a global, high technology industry that is heavily influenced by national governments. Design and production are complex and take place through an international network of suppliers and prime manufacturers. This complexity, together with the volatility and uncertainty of aircraft markets, makes this industry riskier than most other manufacturing sectors.

World aircraft production is dominated by large aerospace and defence conglomerates in a small number of large industrial nations with significant military interests. It is notable that Canada, a mid-sized economy with relatively few military interests, has become such an important player in this industry. Canadian companies compete successfully at all levels of this global industry and are well-positioned for growth, with strong lines of proprietary products, a broad spectrum of capabilities, and an experienced and skilled work force.

Canada's significant role in the aircraft industry began as a result of large government investments and procurements during the Second World War and the early years of the Cold War. These actions helped to develop key technological capability and low-cost manufacturing infrastructure. In the 1960s, the government decided to withdraw support for domestic design and development of military aircraft. In response, the industry became more closely integrated with the U.S. industry

and changed its emphasis to civil products for export. These factors left a competitive legacy that carried the industry successfully through the booming aircraft markets of the 1980s and allowed it to weather the recession of the early 1990s.

Today, the Canadian aircraft industry directly employs 40 000 Canadians in highly skilled, high-paying jobs. It manufactures complex, high technology products such as commuter and business aircraft, helicopters, aircraft engines and other subsystems. Industry shipments are approximately \$5–6 billion annually.

Aircraft trade has been virtually tariff-free since 1979 under the General Agreement on Tariffs and Trade (GATT). Nonetheless, trade and production are heavily influenced by non-tariff barriers, particularly subsidies and government procurement practices. Aircraft markets are truly global, with almost every manufacturer heavily reliant on export sales. The Canadian industry, with a relatively small domestic market, exports more than 70 percent of its production. The U.S. market, by far the most important in aircraft trade, accounts for more than half of Canadian exports.

The industry's products, designed for very demanding customers, require substantial up-front investments in research and development (R&D), which can typically be recouped only over a 20-year product cycle. Aircraft development demands the use of advanced technologies in all phases of product design, production and in-service support. Innovation in airframe and aeroengine design focusses on increased performance while continuing to reduce the manufacturing and operating costs

of aircraft. Improvements tend to be incremental rather than breakthrough in nature, and are often made possible by developments in composites and other advanced materials, automated machining centres, and computer software and hardware.

The key competitiveness factors for prime and major subsystem manufacturers reside in their proprietary product technologies and their competency in utilizing and adapting non-proprietary process technologies. For this reason, product technology is considered a key to competitiveness and has traditionally been jealously guarded. Most Canadian small and medium-sized enterprises (SMEs) are component manufacturers that rely on purchased process technologies and manufacturing process engineering competence for their competitiveness. Since these technologies are available to everyone, it is the application of the most appropriate process technologies that is the source of competitive advantage for these firms.

Aircraft design and integration now are highly automated, shortening design phases and reducing design risk. The larger firms in the aircraft industry have already converted to project management processes and newly developed design tools that facilitate design-for-manufacture, which can reduce production cycle times and costs. The next step will be the migration of these tools and techniques to SMEs as the larger companies push down greater design responsibilities onto suppliers.

Aircraft manufacturing is complex and labour intensive, with thousands of manual steps in the production process. Production is performed in relatively low volumes and, as a result, the industry has lagged behind other manufacturing industries in the adoption of technologies such as robotics. While the introduction of more efficient ways to organize production is under way in major segments of the industry, there remains considerable scope for further improvement.

An indigenous aircraft industry is coveted by governments around the world, due to its strong links to national defence and sovereignty, its prestige value, and its economic benefits such as export revenues, technology spillovers to other industrial sectors and its high-paying jobs. As a result, the hand of government has been pervasive in the development of the international aircraft manufacturing industry — through tariff and non-tariff barriers, direct subsidies such as R&D support, export sales financing assistance, government procurement practices that favour domestic industries and through requirements for industrial offsets.

A number of key processes and operations in the aircraft and aircraft parts industry (especially metal machining, finishing and treatment) utilize or generate materials and wastes that have the potential to produce significant adverse environmental impacts if they are improperly handled or improperly released to the environment. For most processes, appropriate environmental controls and practices are well understood. Regulations are imminent that will ban the use of certain heavy metals. In response, firms are exploring alternative materials and processes that are compliant with the emerging environmental regulations.

Over the past decades, the industry has increasingly directed its efforts to develop more efficient and environmentally friendly aircraft and aircraft parts products. These efforts have been driven by ever more stringent domestic and international environmental standards aimed at reducing aircraft noise and engine combustion products as air travel increases. Ongoing efforts in this area are essential to the future competitiveness of the Canadian aircraft industry. For both airlines and aircraft manufacturers around the world, the introduction of more environmentally friendly products will contribute to sustainable growth.

1.1 Major Trends

To sustain competitiveness beyond the cyclical upturn of the late 1990s, the Canadian industry faces new challenges. The world aircraft industry is rapidly moving away from its historical cost-plus military-oriented culture, focussed on product technology and performance, toward an industry that operates along more conventional business lines, with equal emphasis on manufacturing efficiencies. Changing customer requirements, restructuring of the international industry as a result of overcapacity in some market segments, and the emergence of new competitors are forcing established manufacturers to focus more than ever before on the processes by which its products are designed and manufactured. Cost has become the major competitive factor in the aircraft industry today.

Markets

Customers now are more cost sensitive. Airlines are increasingly basing their decisions on operating cost and financing arrangements as well as purchase price. Military budgets have declined and requirements are being redefined, often along commercial lines.

New competitors are emerging to challenge the privileged relationships of Canadian firms with major U.S. aircraft and aeroengine makers. In the Asia Pacific region, a number of nascent aerospace industries are poised to leverage growing domestic demand for aircraft into an increased role in production and design. Because they can also provide significant up-front capital and/or lower-cost labour, these firms provide an increasingly attractive alternative to traditional suppliers. Eastern European suppliers, with technological capabilities comparable with Canada's, but with substantially lower labour costs, are also now competing with western firms, including Canada's components, subsystems and parts suppliers.

Furthermore, major manufacturers are calling on their subcontractors and subsystems suppliers to shoulder more of the development costs and risks and to provide more complete subsystems. In response to cost pressures, manufacturers are also increasingly seeking international partners to share in the design, development and manufacturing of aircraft. In some cases, international collaboration is also seen as a strategy for gaining market access. Canadian companies could benefit from new and expanded international business relationships.

Technology

In the past, customers (particularly the military) focussed on performance; successful products incorporated the latest (and often most expensive) technologies. Now, although performance remains an important factor, growing price-consciousness among customers and intensified competition among manufacturers have led to a greater focus on cost. This new environment requires that firms continuously reduce their product development and manufacturing cycle times through improvements in design and manufacturing processes and in management techniques, in order to be able to bring new products to market earlier and at a lower cost.

In the coming years, the cutting edge in competition will be how fast, how well and how cost-effectively products can be designed and manufactured. Investing in product technologies will remain critical to creating better, more efficient and lower-cost commercial aircraft. Because of the cost and risk of developing the required technologies, companies are increasingly relying on intercompany and international collaboration.

Airframe and aeroengine design is also placing greater emphasis on design-for-manufacture in order to reduce production cycle times and costs. Whereas manufacturers used to subcontract for production of individual parts, suppliers must now provide fully integrated subsystems.

Industry Canada, jointly with the industry and other government partners, is developing a Technology Road Map and related initiatives to address these competitiveness issues.

Human Resources

Adopting new managerial techniques, shop floor skills, and ways of organizing people and work will be crucial to Canadian companies competing in an industry where there is increased emphasis on improved process technologies. In a labour-intensive and highly unionized industry, this has significant implications for industrial relations, work rules and new skill requirements. Outside the normal collective bargaining process, aircraft industry consultative mechanisms are informal and relatively undeveloped. It has been suggested that improved forums for ongoing labour-management cooperation and consensus may be necessary. The industry will also have to deal with shortages of workers with informatics-related skills as new production technologies diffuse through the workplace.

Government

To counter the subsidies and preferential procurement practices that benefit foreign competitors, government support (for technology development and market access) will continue to be crucial to industry competitiveness. Fiscal restraint, however, places limits on how much support government can provide, and raises questions about what should be the priorities for the available assistance. Moreover, companies still reliant on the domestic military market will need to adjust to lower levels of procurement by the Department of National Defence, and to customers who will look increasingly to commercial-standard products.

To help to level the playing field for Canadian companies and, where necessary, to assist companies to diversify into civil markets, the Canadian government in early 1996 announced Technology Partnerships Canada (TPC). TPC is designed to provide repayable assistance to help the industry finance risky product and process development activities. Industry Canada is also disseminating a number of new information products aimed at improving company access to market intelligence, to techniques for enhancing productivity and to technological knowledge.

1.2 The Bottom Line

For the Canadian industry to maintain or improve its share of the world market for aircraft and parts, the industry must maintain R&D investment to support development of competitive products, continue to improve productivity and to reduce costs, and create new and expanded international business relationships. To accomplish this will require improved relationships between the industry stakeholders, particularly labour and management, and continued government partnership to enhance wealth creation by making Canadian firms more innovative.

The ability to overcome the challenges and exploit the opportunities in the new global environment will vary by the nature of the activities in which each firm is engaged. Canadian companies with a simple build-to-print capability and easy-to-acquire manufacturing technologies, dependent on major customers in North America and Europe, are vulnerable. Companies with a cost-plus military focus, dependent on military

customers, are also vulnerable. Those companies with civil, proprietary products and/or products focussed beyond North American and European markets and with a long-term commitment to cost reduction and innovation are in a better position to compete in the changing global environment.

Industry Canada will explore these issues with the industry and other stakeholders and report on jointly agreed measures to address them in the forthcoming *Framework for Action* document.

2 KEY POINTS ABOUT THIS INDUSTRY

The Canadian aircraft and aircraft parts industry includes firms primarily engaged in the design and manufacture of aircraft and aircraft structural subassemblies and subsystems, engines, equipment and parts, as well as establishments primarily engaged in the repair and overhaul of aircraft and aircraft engines and parts. It is described by Statistics Canada as Standard Industry Classification 3211. A companion document titled *Canada's Aircraft Industry — Background Analysis* contains a more detailed treatment of the material discussed here.

Manufacturers of aerospace and defence-related electronics equipment (such as avionics), while often key suppliers to the aircraft industry, face sufficiently different industry dynamics that they will be dealt with in a separate *Overview and Prospects* to be published in 1997.

2.1 Global Context

Entering and competing in the world aircraft industry demands skills, technology and resources beyond the requirements of most other industries. Aircraft manufacturing is among the most complex functions performed in 20th century manufacturing: hundreds of suppliers coordinate and contribute their input to the manufacture, assembly, integration and certification of thousands of individual components.

**Customers demand
rigorous product safety and
performance standards**

**Heavy R&D investment
is the industry norm**

**High-risk, “bet
the company” ventures
characterize the industry**

The primary customers for this industry — the world's airlines and armed forces — are sophisticated and demanding, with rigorous quality, safety and performance requirements. As these customers are relatively few in number, they exert considerable buyer power in a highly competitive marketplace where there are few uncontested niches. Major airlines demand price and financing concessions, whereas military purchasers have traditionally focussed more on superior performance.

The industry is **research and development** (R&D) intensive. Innovation in airframe and aeroengine design focusses on reducing the manufacturing and operating costs of aircraft by reducing parts counts and optimizing airflow and weight. Weight reductions are being achieved through more efficient structures that have been made possible by recent R&D developments in automated machining and in composites and other advanced materials. Key airframe design improvements centre on the wing and areas adjacent to the engines. Innovation in subsystems and associated product technologies, often aimed at increased passenger comfort and safety, also focus on miniaturization as a key source of further weight reduction.

The industry also relies on substantive scale and scope economies, and faces high barriers to entry. The up-front development costs for a new aircraft or aeroengine are daunting, and can typically be recouped only over a successful 20-year product life cycle in highly volatile and uncertain global markets. With such formidable financial and market risks, the industry is regarded as a “bet the company” business.

Aircraft manufacturing generally is a **labour-intensive, low-volume** business with few opportunities for large-scale automation. Rarely, for example, does complete aircraft production exceed one unit per week. Cumulative experience gained in the labour- and skills-intensive assembly, test and systems integration activities leads to reductions in unit costs through improvements in quality and reductions in manufacturing times, and so yields learning economies. But because of its low-volume production and an historic emphasis on product performance rather than price (although this has now changed), the industry has lagged other sectors in its use of cost-reducing manufacturing management techniques.

The international aircraft manufacturing industry operates within a three-tiered capability hierarchy. An important aspect of the pyramid structure is the upward flow of parts and components **within** the industry. At the peak of the hierarchy are the relatively few “**prime** manufacturers” with the capability to design, integrate, gain certification for and market complete aircraft.

Primes in turn rely on a far-reaching international network of second-tier suppliers of proprietary aircraft subsystems (for example, aeroengines) and major structural components (for example, wings). Competition among second-tier suppliers is particularly “global”; it is commonplace for an airframe to contain major structural components designed and manufactured in several different nations.

Serving both first- and second-tier companies are numerous third-tier suppliers of smaller parts, components and services. Production equipment and techniques for these build-to-print operations are readily available to all competitors.

**Labour-intensive,
low-volume production**

**The industry operates in
three tiers, led by “primes”**

**Primes rely on a global
supplier network**

Aircraft and their subsystems and subcomponents are long-lived products, operated over a period of 25 or more years in a highly regulated and safety-conscious environment. As a consequence, there is a sizable requirement for aftermarket services such as maintenance, repair and scheduled major overhauls. Subsystems manufacturers have tended to control the supply of “authorized” spare parts, and have been able to reap significant revenues from their spares businesses. Fierce competition in the aeroengine subsector has often led manufacturers to price new equipment at or below cost and to rely on the spare parts market to recoup their investment.

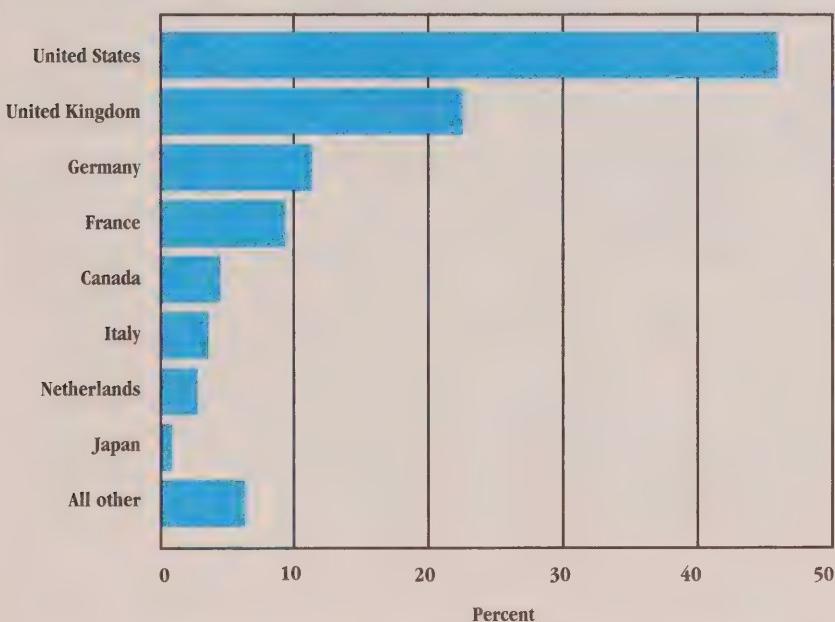
**U.S. and European
conglomerates
dominate primes and
second-tier firms**

Prime and second-tier activities in the international industry are dominated by large U.S. and European aerospace and defence conglomerates closely aligned with their home countries’ national security and military procurement needs. Lockheed Martin, Eurocopter, Bell Textron, British Aerospace, United Technologies, and the three corporations that dominate civil aircraft sales, Boeing, Airbus and McDonnell Douglas, are examples. In addition to aircraft and aeroengine manufacturing, these corporations produce other aerospace and defence-related high technology goods. Many of Canada’s aircraft companies are subsidiaries of these large multinational corporations. Bombardier, the only Canadian-based, large multinational in the industry, with aircraft manufacturing plants in Canada, the U.S. and Northern Ireland, is small in comparison with the U.S. and European aerospace and defence giants.

The United States, the United Kingdom, Germany and France have the most extensive and capable aircraft industries, and together account for over 80 percent of world exports of aircraft, aircraft engines and associated equipment and parts (Figure 1). The United States is by far the largest consumer and producer of both military and civil aircraft. Canada, with a much smaller economy, has a 4-percent share, and leads the second tier of exporting nations, ahead of such larger economies as Italy and Japan. The range of design and manufacturing expertise that has been developed in the Canadian aircraft industry is comparable with that of the German industry, and is broader than that of nations such as Japan, Italy, the Netherlands and Sweden.

Canada is fifth largest exporter worldwide

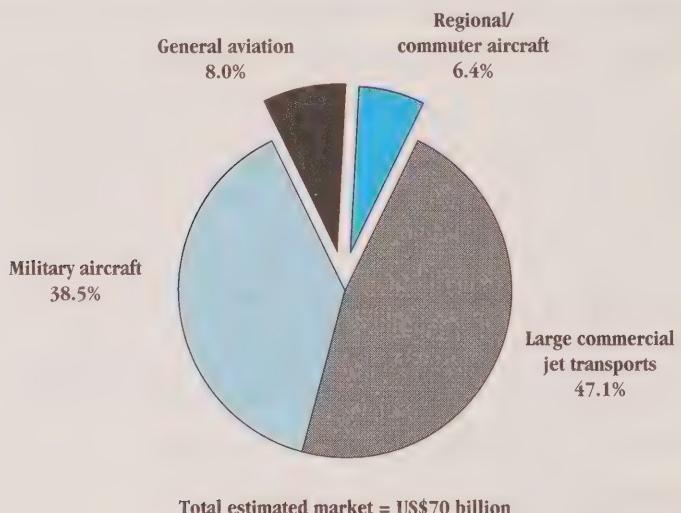
Figure 1. Average Export Shares, by Country, 1980–92



Source: Industry Canada estimates taken from Statistics Canada's World Trade Database.

Worldwide deliveries of *new* aircraft (i.e. excluding sales of subsystems, subcomponents and parts, and repair and overhaul services) are expected to total US\$70 billion in 1996. Sales of commercial jet transports account for approximately one half of this amount (Figure 2).

Figure 2. Estimated New Aircraft Deliveries, World, 1996



Source: Industry Canada analysis of Forecast International/DMS estimates.

Canadian firms are most active in civil markets

Canadian aircraft companies are most active in civil aircraft markets, particularly in the regional/commuter transport, helicopter and executive jet segments. Canadian companies do, however, design and manufacture proprietary subsystems, as well as aerostructures and parts for commercial jet transports and, to a lesser extent, for military aircraft.

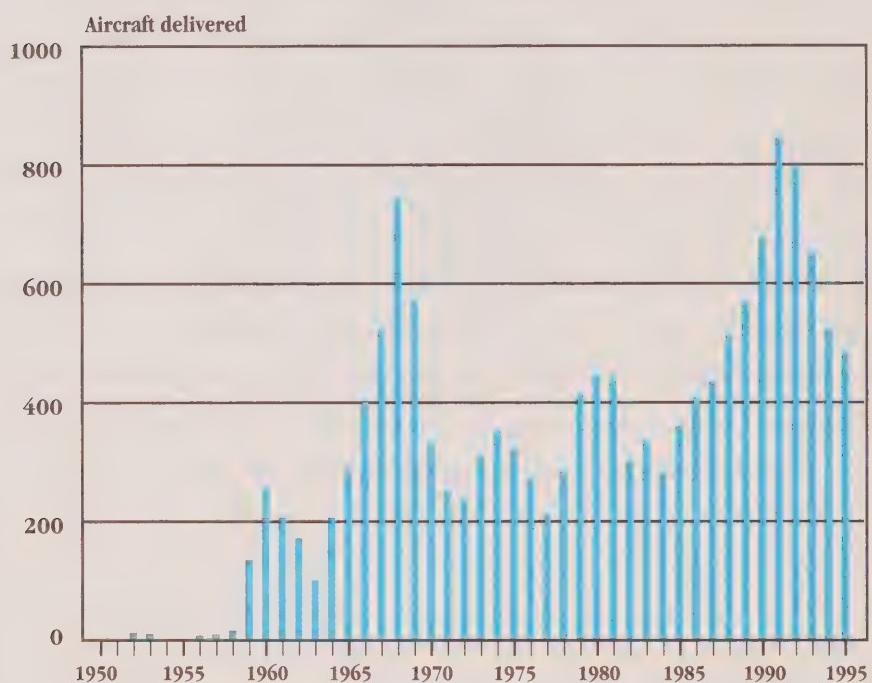
Markets for aircraft are extremely volatile, experiencing turbulence from economic cycles as well as from government policy and regulatory decisions. As a result of this market volatility, the aircraft industry suffers through periods of low capacity utilization and widespread work force reductions during each business cycle.

The swings in aircraft markets are much more pronounced than are those in overall economic activity. This results in part from the relatively long lead times required for an aircraft order. Because changes to the level of production (either up or down) are quite expensive, manufacturers try to schedule an orderly transition through the business cycle. Unfortunately, in times of recovery (when most airlines want more aircraft), this results in large order backlogs and in lead times of two or three years between the placement of an order and the eventual delivery of the aircraft. As backlogs grow, airlines become concerned about whether they will have the capacity necessary to capture air travel growth, and an “ordering frenzy” can result. Inevitably, some aircraft ordered in “good times” are delivered during a subsequent downturn. And during a cyclical downturn, many orders are postponed or cancelled. Hence the characterization of the industry as one of “boom and bust” markets.

**Aircraft markets are
“boom and bust”**

Wide cyclical variations have occurred in jet aircraft deliveries since the beginnings of the jet age in the 1950s (Figure 3). On five separate occasions, annual aircraft deliveries have tumbled by over 35 percent within three or four years. Consistent with this pattern, the latest downturn saw annual deliveries fall by over 40 percent, from 844 aircraft in 1991 to only 483 aircraft in 1995.

Figure 3. High Volatility in Commercial Jet Transport Deliveries by Western Manufacturers



Source: *World Jet Inventory Year-End, 1994*.

Pervasive government intervention

Governments around the world covet an indigenous aircraft industry because of its strong links to national defence and sovereignty, its prestige value, and its economic benefits such as export revenues, technology spillovers to other industrial sectors and its high-paying jobs. As a result, the hand of government has been pervasive in the development of the international aircraft manufacturing industry — through tariff and non-tariff barriers, direct subsidies such

as R&D support, financing assistance for export sales, government procurement practices that favour domestic industries, and requirements for industrial offsets. The enthusiasm of governments has been instrumental in maintaining the chronic excess capacity that plagues many segments of both civil and military aircraft markets.

Furthermore, the aircraft purchase decision now is influenced as much by the nature and cost of financing as it is by the price of the aircraft. Given the cyclical nature of the airline industry and the availability of sophisticated financing instruments, airlines are increasingly leasing rather than purchasing their aircraft (an estimated 20–30 percent of new aircraft are leased to airlines). In this regard they have become extremely sensitive to the terms under which these leases are structured and to the level of credit support that manufacturers or their supporting government (through export credit agencies) can offer.

**Financing affects purchases
as much as price does**

Aircraft financing is a particularly important issue in the **commuter/regional aircraft market**, where a significant number of customers do not have a strong financial position and there is an oversupply of competing regional aircraft products. This situation has brought downward pressures on prices, and has led to aggressive manufacturer financing and related incentives such as buy-backs, offsets and very low interest rates. In this market, government support in the form of loan guarantees in the event of lessee default or return of the aircraft to the lessor before expiry of the lease is usual. This is especially the case with new aircraft models that have not yet gained widespread market acceptance and for which stable residual values have not yet been established.

Through international agreement, some limited disciplines on government intervention are in place. The 1979 Civil Aircraft Code under the General Agreement on Tariffs and Trade eliminated tariff barriers between signatories on civil aircraft products. An Organisation for Economic Co-operation and

**GATT limits government
intervention — somewhat**

Development (OECD) Consensus imposes some controls on government-supported export sales financing activities. Many aspiring aerospace nations, however, are not signatories to these agreements. Moreover, even signatories to the agreements use national security exceptions to impose domestic content requirements on (primarily military) government procurements and to provide direct financial assistance to the industry.

2.2 Canadian Industry Snapshot

Canada's aircraft industry employs 40 000 in 200 plants

The Canadian aircraft industry consists of approximately 200 plants employing approximately 40 000 workers. Industry shipments are approximately \$5–6 billion annually. The industry's output includes an impressive range of high-technology, proprietary products such as Canadair's **Regional Jet** transport and **Challenger** and **Global Express** business jets, de Havilland's **Dash 8** family of commuter transports, **civil helicopters** produced by Bell Helicopter Textron (Canada) and the family of **small aircraft engines** designed and produced by Pratt & Whitney Canada. Canadian firms also produce **aircraft subsystems, structural components and other parts** for aircraft companies in Canada, the United States and Europe, and carry out **repair and overhaul** on a wide range of aircraft, aeroengines and their parts.

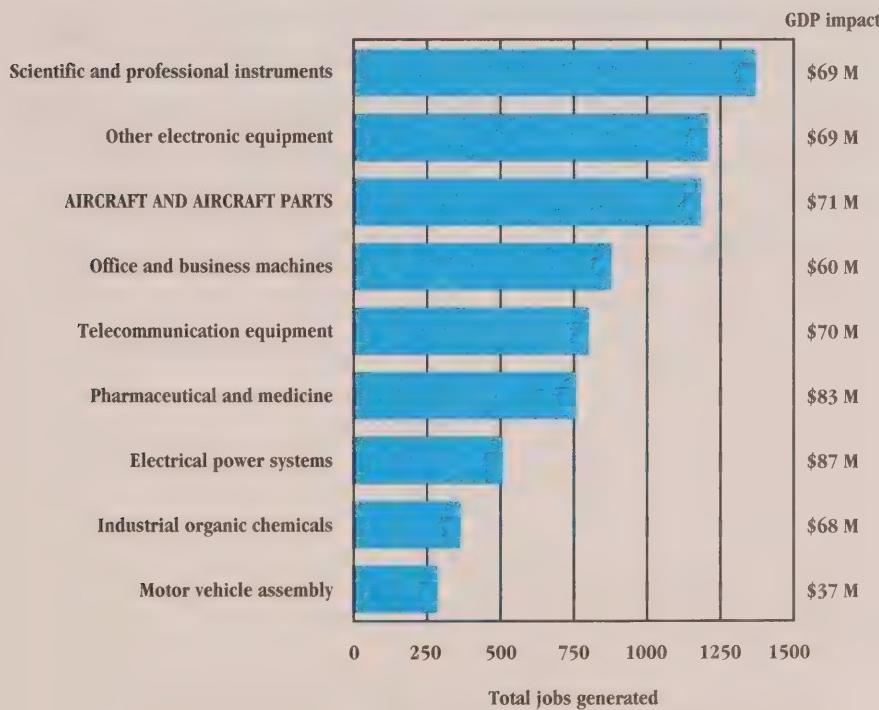
Largest 16 plants employ 75%, achieve 80% of production

While the number of smaller firms participating in the Canadian industry has increased over the past two decades, the largest 16 establishments (those with 500 or more employees) account for 75 percent of total employment and more than 80 percent of total production. These larger firms also achieve significantly higher value-added per employee than do smaller firms.

Aircraft manufacturing is a **high-value-added** industry; value-added has consistently accounted for 55–60 percent of the total value of industry output. The aircraft and aircraft parts industry is one of the strongest generators of jobs and national income among Canada's high-technology, knowledge-intensive industries (Figure 4). For example, an increase of \$100 million in aircraft industry output in 1990 would have led to an estimated increase in output from the rest of the Canadian economy of almost \$47 million, and would have generated \$71 million in national gross domestic product (GDP). Furthermore, because the aircraft industry is relatively **labour intensive**, a \$100-million increase in output in 1990 would have generated 869 jobs in the aircraft industry itself and 316 jobs in other sectors of the economy. The relatively low job creation outside the industry is a result of the aircraft industry's rather limited linkages to the rest of the economy. This weakness is due in part to the need to import most key raw materials and some subsystems.

**Aircraft industry is
a powerful generator
of jobs, GDP**

Figure 4. Impact of a \$100-million Increase in 1990 Output of Selected Canadian High-tech Sectors on Employment and GDP



Source: Industry Canada estimates based on a special tabulation by Statistics Canada.

**Direct labour costs account
for only 20% of production**

Although the industry is labour-intensive, direct labour costs (production wages) make up less than 20 percent of the total value of production. Salaries paid to non-production workers, which account for a further 10–15 percent of total production value, are particularly significant, reflecting the amount of product design and engineering effort required in aircraft and aircraft parts manufacture. Purchased goods and materials (including not only raw materials, but also subcontracted component manufacture and subsystems such as engines) account for about 40 percent of the total value of production.

**Canadian-owned firms
earn 45% of revenues;
U.S.-owned firms, 42%**

The relatively high level of foreign ownership and control distinguishes the Canadian aircraft and aircraft parts industry from its international counterparts. Approximately 45 percent of total industry revenues are earned by Canadian-owned companies, and 42 percent by U.S.-owned operations. The structure of Canada's aircraft industry is presented in Table 1.

An important prime manufacturer, Bell Helicopter, and over half of the second-tier organizations are foreign owned, predominantly by multinational aerospace and defence conglomerates. They encompass a varying degree of autonomy or integration with their parents, ranging from companies that have a full world product mandate for products they design, market and support (e.g. Pratt & Whitney Canada), to captive subsidiaries that rely primarily upon their parent's design and marketing capabilities (e.g. Boeing Canada and McDonnell Douglas Canada).

Table 1
Canadian Industry Structure^a

FIRST TIER — PRIMES	
Canadair/Bombardier	— Regional Jet, Challenger, Waterbomber
de Havilland	— Dash 8
Bell Helicopter/Textron Canada	— Civil helicopters
SECOND TIER	
Pratt & Whitney	— Small gas turbines
Messier-Dowty	— Landing gear
AlliedSignal Aerospace	— Fuel control systems
McDonnell Douglas Canada	— Wings for commercial jets
Boeing Canada	— Major substructures for commercial jets
Fleet Aerospace	— Helicopter cabins
Avcorp	— Aircraft structural components
Héroux	— Landing gear
Menasco	— Landing gear
THIRD TIER	
130+ Canadian aircraft industry firms	
[most employ fewer than 50 people]	
<input checked="" type="checkbox"/> Specialized products/services <input checked="" type="checkbox"/> Components and parts	
REPAIR AND OVERHAUL	
Orenda , Rolls-Royce CAE Aviation , Standard Aero Field Aviation , IMP Aerospace Conair , Kelowna Flightcraft	

^a Boldface indicates Canadian-owned company.

Canada's aircraft industry is heavily concentrated in the provinces of Quebec and Ontario, which together account for over 80 percent of total activity. Nonetheless, it is a major contributor to the economies of other provinces as well. For example, aircraft and aircraft parts shipments ranked first among manufacturing industries in 1990 in Manitoba, third in Nova Scotia and fourth in Quebec. The aircraft industry is the most significant generator of manufacturing value-added in both Manitoba and Quebec.

**Aircraft industry offers
high-quality jobs to
a highly paid and highly
skilled work force**

Human Resources Because aircraft manufacturing relies on intensive use of both R&D and labour, the quality of its human resources is a critical element in the industry's competitiveness. The industry employs a significantly higher proportion of engineers and technicians than most other manufacturing industries. The production work force is concentrated in higher-skilled (and higher-paid) occupations in fabrication, assembly, machining and mechanical repair. Remuneration in these occupations tends to be higher in the aircraft industry than in other sectors of the economy.

The volatile nature of aircraft markets means the industry's work force experiences significant layoffs in a cyclical downturn, followed by equally significant hiring in an upturn. Labour adjustment during business cycles is therefore a major challenge for the industry, particularly vis-à-vis the retention and recall of skilled workers.

**New technologies and skill
requirements are affecting
traditional shop floor jobs**

Structurally, the industry has experienced important adjustments in the skills and occupational composition of its work force. This can be attributed in part to the introduction of new production and process technologies that reduce the industry's dependence on traditional crafts and skilled trades processes.

Employment losses during the last recession resulted primarily in layoffs of production workers and a number of white-collar occupations (for example, administrators, managers and marketing professionals whose number had increased significantly during the boom years of the 1980s). By comparison, employment of engineers, system analysts and technicians, which also experienced a strong growth in the 1980s, remained relatively stable during the following recession.

The aircraft industry is highly unionized: 70 percent of the work force are union members, compared with 36 percent in the Canadian manufacturing sector and 29 percent in the economy as a whole. Over half of the unionized work force are members of the National Automotive, Aerospace and Agricultural Implement Workers of Canada (CAW), and about 20 percent belong to the International Association of Machinists and Aerospace Workers (IAM).

The industry does not have as well-developed a consensus-building labour-management forum as some other sectors do. Labour-management relations have been strained at times in the past, although the pattern varies from establishment to establishment. Some older and larger firms have had major strikes.

Most major aircraft and aircraft parts manufacturing firms are members of the Aerospace Industries Association of Canada (AIAC). Many companies with interests in military markets are members of the Canadian Defence Preparedness Association (CDPA). Provincial aerospace associations or councils, which promote the interests of aircraft industry firms, operate in Nova Scotia, Newfoundland, Ontario, Manitoba, Alberta and British Columbia.

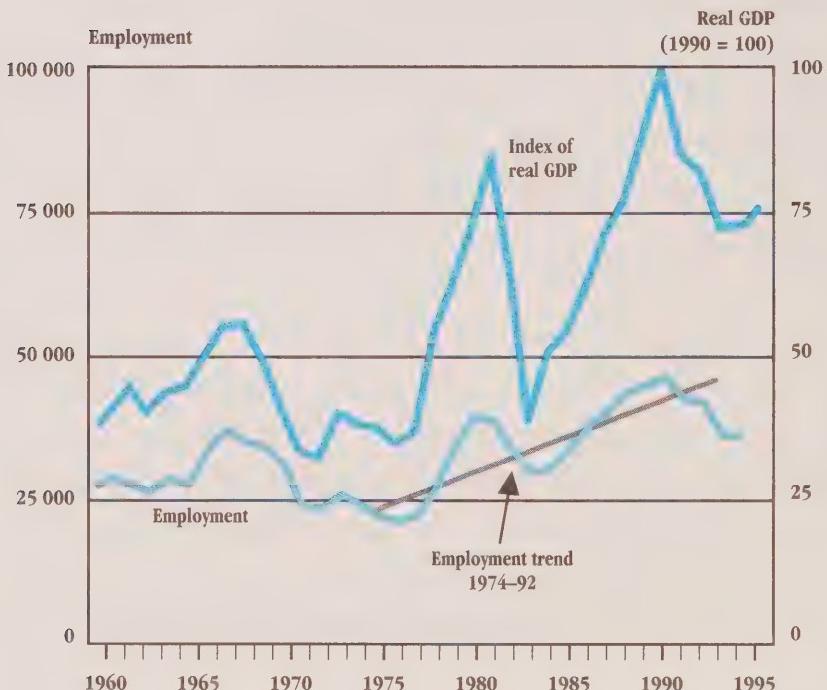
**Majority of workers
belong to a union**

**1996 is likely to be
a record year for production**

2.3 Performance and Competitiveness

Although Canadian industry performance has mirrored the boom-and-bust of world aircraft markets, industry output between the mid-1970s and 1990 grew by 150 percent (Figure 5). Employment has followed the movement in real output, peaking in 1990 at more than 46 000 workers, up 80 percent from average levels in the early 1970s. This growth far exceeded the increase in total manufacturing employment over the same period. After falling 25 percent in the early 1990s due to the recession and the decline in civil aircraft markets, the industry's real output began to recover in 1995; by early 1996, the value of monthly shipments had reached record highs.

Figure 5. Canadian Aircraft Industry Employment and Output



Source: Industry Canada analysis of CANSIM series D666462 and I34375.

This successful performance is a legacy of several decades of development and manufacturing experience nurtured by a supportive government environment. Indeed, the industry's ability to survive volatile aircraft markets and take advantage of the upward trend in aircraft demand has been heavily influenced by government actions that stretch back to the Second World War.

Government initiatives initially provided the industry with a cheap manufacturing infrastructure. To maintain a domestic production capability for national security purposes, the Canadian government directed the installation of much of the plant and equipment that allowed Canadian companies to undertake licensed production of thousands of military aircraft. Later, the government introduced policies that integrated the industry more closely with the U.S. industry, providing access to markets and technology as well as financial support for high-risk, advanced product development, and encouraging a reorientation toward civil markets.

Despite the relatively lean years for the industry during the 1960s and the early 1970s, the industry's civil realignment began to bear fruit by the mid-1970s as a new generation of civil aircraft products for export took shape. Government support policies attracted a number of major foreign manufacturing plant investments and financed the development of new civil aircraft designs that continued to generate strong sales through the mid-1990s.

**War gave Canada's
industry its first big boost**

**Canadian aircraft industry
integrated with
the U.S. industry**

**The 1960s and 1970s
were lean years**

The Canadian aircraft industry was thus on a strong footing when civil and military aircraft markets boomed during the 1980s. Deregulation of the U.S. airline industry gave rise to numerous regional airlines and coincided with significant air travel growth. Canada's specialization in regional airliners and small turbine engines meant Canada was well placed to take advantage of this market growth.

In passing through these phases, the Canadian industry was transformed from an industry dependent on domestic military procurement to one largely focussed on civil and export markets.

Canada's move to civil production paid off

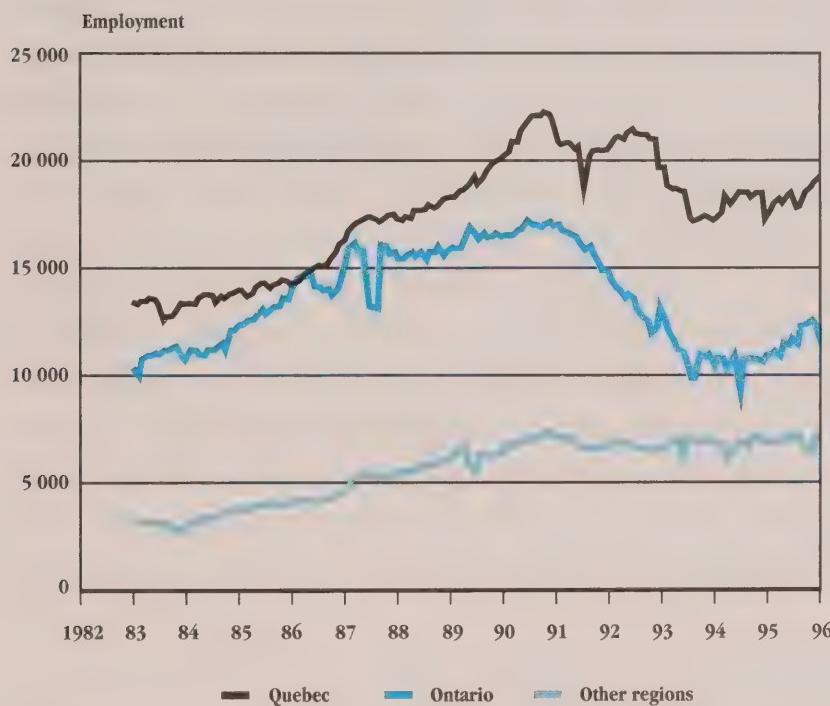
Although battered by the cyclical downturn in civil aircraft markets in the early 1990s, the Canadian industry's focus on civil markets meant that it suffered less than many of its international counterparts. In countries such as the U.S. and France where, unlike Canada, a significant proportion of output is bought by the domestic military, the end of the Cold War saw output and employment decline proportionately more than in Canada. Other leading aircraft nations, such as Germany and the Netherlands, also suffered relatively more than Canada.

Within Canada, the effect of the recession in civil aircraft markets was most pronounced in Ontario, where employment declined by 43 percent or more than 7000 jobs between 1990 and 1993 (Figure 6). In Quebec, 5000 jobs were lost by mid-1993 (a decline of 23 percent in employment). In the other provinces, total industry employment was relatively unaffected by the recession, largely because of the importance in these regions of repair and overhaul activities, which are less directly tied to economic cycles.

**1990s recession hit
Canada less than many
competitor countries**

**Variable regional
employment responses
to cycles in civil aircraft
markets**

Figure 6. Canadian Aircraft Industry Employment, by Region



Source: Statistics Canada, *Monthly Survey of Manufacturing*, Catalogue No. 31-001.

Canada exports**70% of production**

With only a small domestic market, foreign trade is of critical importance to the Canadian aircraft industry, which looks to foreign markets for over 70 percent of its sales. Canada ranks fifth among world exporters of aircraft and aircraft parts, and is one of only a very few nations that achieves a surplus in aircraft industry trade. Indeed, aircraft manufacturing is the only Canadian high-technology manufacturing sector that consistently generates a trade surplus.

During the 1982–91 boom in the aircraft market worldwide, the Canadian industry's exports of aircraft and aircraft parts increased by more than 50 percent in real terms, outpacing the worldwide expansion in trade. In 1994, Canada was a net exporter of aircraft and parts — \$4.2 billion exported versus \$2.75 billion imported. About 38 percent of all materials and services purchased by the aircraft industry, including a great deal of the raw materials, are imported.

Traditionally two thirds of Canada's exports have been shipped to the United States, because of the dominant position of the U.S. in the aircraft market as a customer as well as a supplier. Canada's exports to the United States increased in real terms by 13 percent between 1988 and 1993, while exports to western Europe increased by 86 percent, reaching 21 percent of total exports.

**Canada has established
market niches in
landing gears, large
business jets, small
turbines, helicopters and
commuter/regional aircraft**

The success of the Canadian aircraft industry is amply demonstrated in its strong export performance and its competitive strength in international markets. A number of Canadian companies have built strong positions in world aircraft markets with their advanced products. For example, Pratt & Whitney Canada is the world's leading producer of small gas turbine engines for the general aviation, commuter aircraft and helicopter markets. The Canadian industry has also captured more than 25 percent of the world landing gear market and one third of the large business jet market.

Over the past two decades, increased investments in R&D, machinery and equipment, and human resources have made a major contribution to the strength of Canada's aircraft industry. The continuing support of the Canadian government in this regard has helped to produce an industry that employs state-of-the-art technologies to design, develop and manufacture innovative proprietary products.

The aircraft industry faces a constant requirement to undertake substantial investments in R&D to sustain technical leadership in its proprietary products. The industry is one of the largest investors in research and development in the Canadian economy. Investment in R&D averages 8 percent of total industry sales (including sales of many firms that perform no R&D). Among only those companies that do perform R&D, Canadian aircraft industry firms have been more aggressive than U.S. firms at reinvesting their own profits in R&D; private funding of Canadian industry R&D amounted to almost 10 percent of performing company net sales, compared with only 3–5 percent in the United States.

The industry's R&D efforts have been supported by federal government programs, which provided 27 percent of the \$469 million spent on R&D in 1991. Nevertheless, government sharing ratios for *aerospace* industry R&D in Canada have been considerably lower than in the U.S. and in most other leading aerospace nations.

Such international comparisons must be made cautiously, however, since much more of the R&D activity in foreign aerospace industries has been for military equipment, for which governments (as the primary or sole customer) typically pay all product development costs. **Cross-subsidization** from military-supported R&D to commercial products has underpinned the development of the aerospace industries of most of Canada's chief competitors.

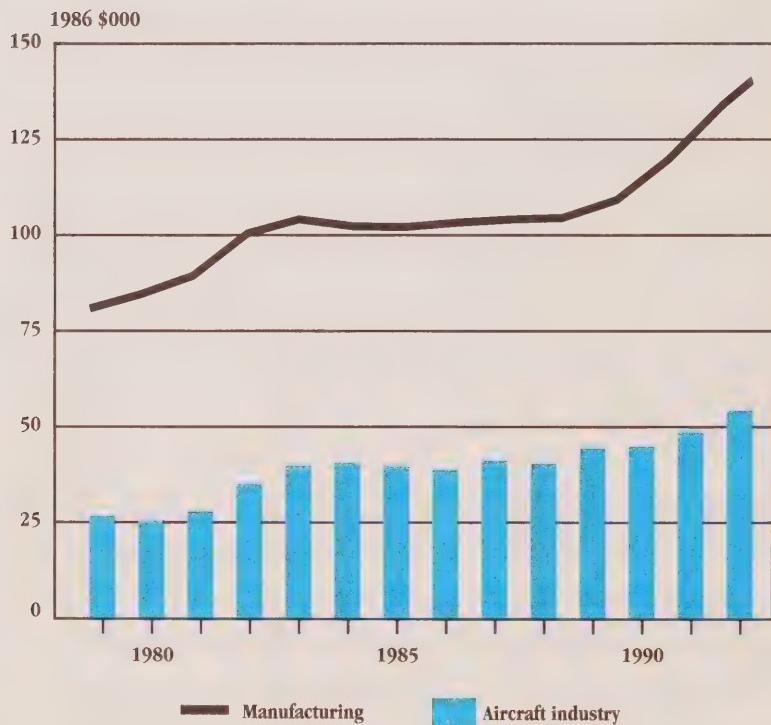
**R&D investment keeps the
industry competitive**

**Aircraft industry
is labour intensive**

Aircraft manufacturers are early adopters of state-of-the-art design and manufacturing technologies requiring sophisticated and expensive machinery such as computer-aided design and manufacturing (CAD/CAM) engineering workstations and computer numeric controlled (CNC) machining centres. During the 1980s, the Canadian industry's capital investments in structures, machinery and equipment tripled in real terms and the industry's capital stock doubled, the latter growing more rapidly than that of manufacturing overall. Nonetheless, the aircraft industry is among the least capital-intensive sectors in Canadian manufacturing. Aircraft and aircraft parts production, with its relatively low production volumes, typically has required only 40–60 percent of the capital per worker utilized in the manufacturing sector overall (Figure 7).

**Low levels of
capital employed in
the aircraft industry**

Figure 7. Capital Employed Per Worker



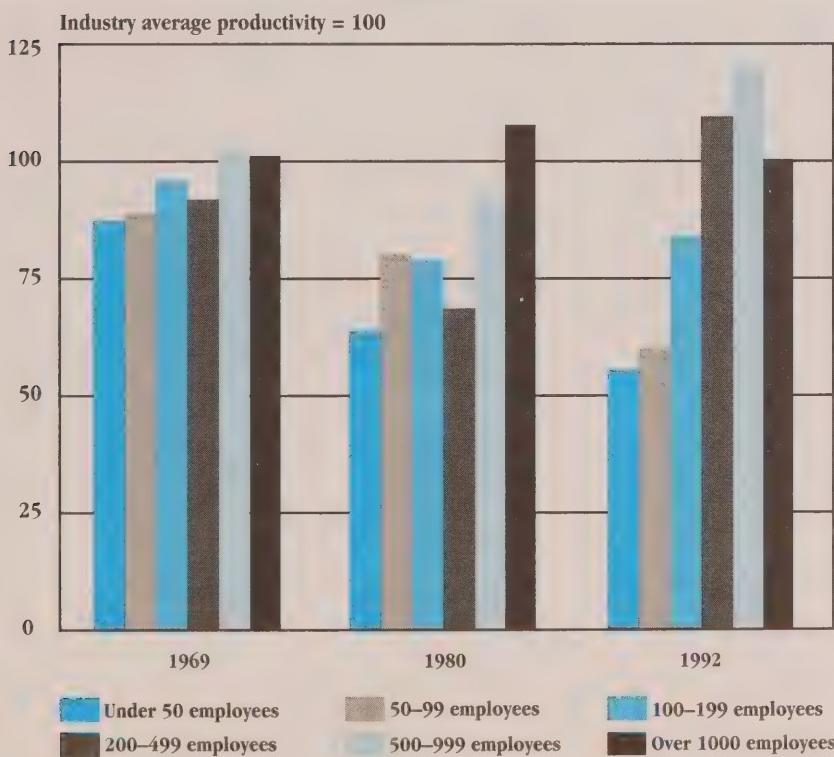
Source: Industry Canada estimates based on data from Informetrica Ltd.

The aircraft industry is a relatively efficient user of capital and labour in combination: aircraft industry workers produce roughly the same value-added as do manufacturing workers overall, while employing significantly less plant, machinery and equipment. Over the past two decades, however, productivity gains in the aircraft industry have lagged behind those achieved in the overall manufacturing sector. This inability of the aircraft industry to demonstrate significant increases in productivity despite increased capital investments is potentially a cause for concern.

The productivity gap between workers in small firms and those employed at the largest plants in the industry has widened dramatically over the past two decades (Figure 8). In 1992, the productivity leaders in the industry were those plants employing between 200 and 1000 workers. A productivity gap has also emerged between regions, with labour productivity in Quebec roughly double what it was elsewhere during the early 1990s.

Aircraft industry
productivity has lagged
that of manufacturing

Figure 8. Total Value-added per Employee, by Establishment Size, Canada



**The aircraft industry
offers only modest
return on investment**

Data on aircraft industry profitability have not been published in recent years by Statistics Canada. In general, the published data (for 1972 to 1987) suggest that there has been a lower rate of return on capital in the aircraft and aircraft parts sector than in the manufacturing sector as a whole. This is consistent with evidence from Australia and the United States.

Aircraft and their parts are priced and purchased in U.S. dollars worldwide. As a result, Canada's aircraft and parts exporters, because they are paid in U.S. dollars, enjoy much stronger profit margins when the Canadian dollar is weak relative to the U.S. dollar. The Canadian industry's competitiveness and profitability are particularly enhanced when the Canadian dollar trades below 80 cents U.S., as it has since 1993.

Sustainable Development A number of key processes and operations in the aircraft and aircraft parts industry (especially metal machining, finishing and treatment) utilize or generate materials and wastes that have the potential to produce significant adverse environmental impacts if they are improperly handled or improperly released to the environment. For example, the aircraft industry makes extensive use of cadmium, chromium and nickel in surface finishing processes for parts that are subject to corrosion. These heavy metals are currently on the list of hazardous materials to be banned shortly by the U.S. Environmental Protection Agency, Environment Canada and environmental agencies in many other countries. In response, the industry is actively exploring alternative materials and processes that would comply with environmental regulations in countries that would buy or use these products.

Over the past decades, the industry has increasingly directed its efforts to developing more efficient and environmentally friendly aircraft and aircraft parts products. These efforts have been driven by ever more stringent domestic and international environmental standards aimed at reducing aircraft noise and engine combustion products as air travel increases. Ongoing efforts in this area are essential to the future competitiveness of the Canadian aircraft industry. For both airlines and aircraft manufacturers around the world, the introduction of more environmentally friendly products will contribute to sustainable growth.

**More enviro-friendly
products are required**

Government Policy and Support

Canada's industrial policy in the aerospace sector has actively promoted the development of a diversified, internationally competitive, private sector industry. At the same time, the policy has recognized the need to place Canada's industry on an equal footing with foreign competitors assisted by their respective home governments.

**Government support levels
the playing field**

Market Access Canadian policy has focussed on eliminating or limiting structural impediments to trade through endorsement of the Agreement on Trade in Civil Aircraft within the General Agreement on Tariffs and Trade (GATT, now the World Trade Organization or WTO) and participation in the OECD Consensus arrangement to limit government-assisted financing support for civil aircraft sales. The aircraft industry also makes extensive use of the sales financing services (loans, loan guarantees and loan/lease insurance) of the Export Development Corporation.

Government Procurement. Although playing less of a role in assisting the industry than in the past as a result of more stringent international trade rules and the shift in orientation of the industry toward civil aircraft, government procurement does provide market access and industrial development leverage. Government purchases of prototype aircraft products enhance the technological capabilities of the industry and, by acting as a launch customer, the government has also helped establish the credibility of Canadian products in international markets. Industrial benefits and offsets negotiated on major military procurements have facilitated the development of business relationships between domestic suppliers and foreign prime manufacturers, countering the market-distorting offset and domestic content policies of other countries that are particularly prevalent in military aircraft markets.

Direct Involvement. Direct government financial support has concentrated on R&D and restructuring activities. The most prominent program in this area was the Defence Industry Productivity Program (DIPP), which provided funding for product development, cost shared with companies, along with some financing of source establishment and capital equipment. In 1995, the federal government withdrew further funding for new initiatives under DIPP pending a review of government R&D support. In early 1996, the government launched Technology Partnerships Canada (TPC), a new R&D risk-sharing program supporting a number of high-technology sectors, including aerospace.

The industry has access to government-financed aeronautical research facilities, although they are not as extensive as U.S. and European institutions. These facilities include the National Research Council's wind tunnel and structural test laboratories and the research establishments of the Department of National Defence.

3 CHANGING CONDITIONS AND INDUSTRY RESPONSE

3.1 Changing Global Conditions

In 1996, aircraft markets are in the midst of yet another strong cyclical recovery as world economies strengthen, air travel grows again and airline profitability returns. The current recovery, however, masks a number of longer-term trends among the customers for aircraft and within the world aircraft industry. These trends are fundamentally changing the business of aircraft manufacturing and affecting the competitive position of the Canadian industry. They are influencing the demand for new aircraft, the prices paid for new aircraft and the likely sources for the greatest growth in new aircraft demand. As well, these trends are stimulating new competitors who will challenge the Canadian industry.

Both civil and military buyers have become more cost sensitive and are looking more closely at the value provided by new aircraft equipment. On the civil side, one historical trend in the airline industry likely to continue is the decline in passenger revenues on a per-seat-kilometre basis, commonly known as yield. The price-sensitive leisure traveller is becoming a larger segment of the market, while businesses are taking steps to avoid the premium airfares traditionally charged business travellers. On top of this, the deregulated North American market continues to make it relatively easy for discount fare airlines to enter the business, further pressuring airfares and profits. A similar situation will probably develop in Europe as it, too, moves to deregulate airlines.

Cost sensitivity

characterizes customers

Because their profits will have to be eked out of lower per-seat revenues, the willingness of airlines to buy new aircraft will continue to be strained. When buying new aircraft, airlines are looking not only for low acquisition cost (and sometimes flexibility in ownership through leasing), but also for the lowest possible operating costs (guaranteed in the purchase contract by the airframe and engine manufacturers). Many airlines may opt to keep using older aircraft, whose acquisition costs have already been amortized, sometimes by undertaking “hushkitting” or other modifications in order to meet stricter noise regulations.

In the U.S. and Europe, military aircraft buyers have been hit by shrinking budgets since the dissolution of the Soviet Union and reductions in traditional East-West tensions. U.S. Department of Defence outlays on military aircraft procurement, for example, have halved since peaking in 1987, dropping to just US\$16 billion in 1995. Fewer new military aircraft programs and procurements are expected. Instead, scarce budget resources will be weighted toward research into maintaining a superior, leading-edge technological capability. Existing aircraft “platforms” will be repaired and overhauled, and upgraded with new electronic systems, to keep them flying beyond their planned life expectancies. Where new aircraft are required, acquisition and operating costs will be just as significant as technology, and military buyers will increasingly adapt cheaper, existing commercial “off the shelf” equipment to their needs.

**Airline restructuring
generates increased
buyer power**

Heightened cost sensitivities are compounded by the increasing buying power of aircraft customers. The airline industry is in the midst of a major restructuring as North American, European and Asian international carriers integrate their flight schedules and initiate cross-ownership of each others' shares. In time, the world air travel market may come to be dominated by a small number of global megacarriers. Orders for new aircraft by these

megacarriers, or their aircraft leasing counterparts, will be so large as to command severe price concessions from manufacturers. Similarly, in response to shrinking budgets, even military aircraft buyers are strengthening their buying positions by merging the requirements of separate military services, as in the U.S., or by merging the separate requirements of nations, as in Europe.

Fewer new aircraft program launches by manufacturers are expected as budgets for military aircraft procurement decline and most civil aircraft market segments remain heavily contested by competitors. Only two market segments remain untapped: a long-range subsonic transport with 500–800 seats and a commercially viable supersonic transport. At this time, however, airline interest in such aircraft types is lukewarm at best, and the huge up-front development costs for a less certain market than for most aircraft development programs are putting a damper on enthusiasm among prime manufacturers.

New aerospace competitors are emerging from shifts in world economic growth patterns and the easing of East-West ideological tensions. Historically, aircraft markets and manufacturing have been centred in North America and Europe. While these centres will continue to be important, other regions are presenting new business opportunities for traditional supplier nations such as Canada. They represent, as well, additional sources of supply that present a competitive threat to traditional supplier nations.

In the Asia Pacific region, the most vigorous growth in both civil and military aircraft markets is expected to occur. This growth is bringing with it aspirations among the nations of the region to expand their nascent aircraft industries. China, in particular, but other countries as well, are taking advantage of their increased demand for aircraft to lever work shares from prime and subsystem manufacturers in return for market access. Rising prosperity in the region

**Military cutbacks,
keen competition reduce
new projects**

**Pacific Rim and former
East Bloc offer fresh
markets — and competition**

has provided governments with the resources to develop indigenous aircraft industry competency, as well as the ability to provide local suppliers with the up-front capital required to buy into new aircraft programs. The low labour costs in many of these countries make them attractive alternative sources of supply.

In eastern Europe, the end of the Cold War has opened up aircraft markets and has made available new low-cost sources of supply. Limited opportunities now exist to sell western aircraft and subsystems in the former East Bloc countries. More significantly, these countries have design and manufacturing capabilities in certain areas that are technologically equivalent, or superior to those of the West, but with lower-cost, skilled work forces. The major constraints on the success of these suppliers is a less-developed business infrastructure and business culture. As these firms improve their marketing skills and the ease of doing business in eastern Europe improves, however, they are likely to become formidable competitors. Western prime and subsystem manufacturers are already forging partnerships and sourcing components and machining work with third-tier suppliers in former East Bloc countries.

Competition heats up in civil markets

The significant decline in western military aircraft procurement has also given rise to increased competition for remaining civil work. Some military aircraft makers and suppliers are diversifying into civil markets. In the U.S., these developments have been aided by some redirection of government technology support toward commercial aerospace endeavours and to areas, such as production process R&D, that will benefit commercial aerospace activities.

3.2 The Industry's Response

Changing global conditions are fundamentally affecting the way the aircraft industry operates. Heightened cost sensitivities among aircraft buyers, and new competitors are propelling the industry away from its historical roots in a cost-plus military culture focussed on product technology and performance. Increasingly, the industry is operating along more conventional business lines, with equal emphasis on manufacturing efficiencies in the form of new processes and new supplier relations. As well, the industry is experiencing increased international collaboration and the beginnings of a significant restructuring, including some major moves in sectors important to the Canadian industry.

In the past, aircraft industry competition revolved around radical breakthroughs in airframe and engine technology, often driven by the performance requirements of armed forces. Later, these new technologies found their way onto civil aircraft, improving the productivity of airlines. For example, the greater speeds, ranges and carrying capacities of the first jet airliners translated into huge cost advantages over earlier piston engine designs, as did successive generations of wide body jets and turbofan engines. During this period, performance and productivity improvements more than made up for the increased development (and hence, acquisition) cost of new aircraft and aeroengines. While risky product developments remain at the heart of industry competition, in recent years innovation has been more incremental in nature, aimed at achieving not only improved fuel efficiencies, reduced maintenance expenses and other aircraft operating cost savings, but also greater efficiencies in production.

**The industry is turning
attention to improved
management of design and
manufacturing processes**

The industry now is focussing as much on introducing new management techniques and manufacturing processes to lower the cost of designing and making the product as it is on developing new product technology. To be sure, the industry has been a leader in developing and applying certain advanced production equipment (the “hard technology”). The industry, however, has lagged other manufacturing industries in new, more efficient ways of managing and organizing work processes (the “soft technology”). For example, some leading aircraft makers are borrowing production methods from automobile makers. In Canada, Bombardier has migrated more efficient manufacturing processes from its other transportation equipment divisions to its de Havilland and Canadair aircraft plants.

Efforts at cost reduction have targeted all business processes, but have focussed most dramatically on the integration of design and production operations. The primes have eagerly adopted the latest advances in CAD/CAM and a host of supporting tools, and are compelling their key subsystems and subcomponents suppliers to use compatible systems. As a result, subsystems and components are increasingly being designed with ease of production and assembly in mind (design-for-manufacture). Through the use of concurrent engineering, which brings together specialists from design engineering, manufacturing, assembly and after-sales support to develop a complete solution, drawing board-to-assembly times have been reduced. Primes and major second-tier suppliers are also reducing their cost structures by adopting “smarter” management techniques such as Total Quality Management (TQM) and by helping their suppliers to introduce similar regimes.

The implementation of new managerial processes and the introduction of more advanced design and manufacturing technologies have lowered the costs associated with the mistakes and rework traditionally encountered during the early stages of the production process. These changes are, for the first time, seriously tackling the thousands of manual steps traditionally involved in aircraft manufacturing, thus significantly reducing the number of hours required for assembly of the first units. They also mean, however, that the potential for learning economies is being “designed out” of the manufacturing operation, thus lessening the competitive advantage traditionally enjoyed by established supplier nations with experienced work forces.

Alterations in processes internal to the firm are being complemented by the introduction of new supplier relations. Suppliers are now expected to deliver continuous cost reductions, and supplier networks are being streamlined. For example, in the United States, the number of aerospace/defence suppliers in 1992 was only one quarter the number of the mid-1980s. The volume of work each receives, however, has been significantly increased. In the newly developing relationships, suppliers can expect more intense competition for a “place in the program.” Their return, if the overall project is successful, is a larger share in the production, as purchasers maintain a longer-term relationship with the smaller number of successful suppliers.

Aircraft manufacturers are also passing on some of the risk and financing costs associated with the development of new aircraft. Key second-tier suppliers are increasingly required to become full “**risk-sharing** partners.” In the past, a portion of the initial non-recurring costs under a supplier contract

**Suppliers now are forced
to share more of the risks
(returns)**

was reimbursed early in the program by the prime manufacturer. Now, as risk-sharing partners, they must shoulder the same market risks as the prime manufacturer, with the recovery of their investments contingent on market success.

Aspiring suppliers are sometimes being asked to come up with front-end capital as a “buy-in fee” for participation on an aircraft program. Primes are also increasingly subcontracting with one supplier for a complete subsystem, such as an undercarriage, complete with wheels, brakes, landing gear, etc., all items that previously were separately contracted for by the prime. This trend has further reduced the number of suppliers, but also has increased the level of systems integration capability required of some suppliers.

**International collaborations
are increasing, particu-
larly with emerging
aerospace nations**

International collaborations, an integral part of the aircraft industry for many years, are an increasingly prominent risk-sharing strategy. Faced with increased globalization, rising product development costs and rapid technological changes, these partnerships have been formed not only to spread financial risk and to reduce the considerable technological risks but also to enhance market access. Extensive international sourcing arrangements in a variety of countries can also protect a prime’s cost structure from unfavourable currency fluctuations.

Perhaps the most visible collaborations in commercial transport markets are the Anglo-French Concorde supersonic transport and the European Airbus consortium. Teaming among primes has also been commonplace with military aircraft programs, where increased market access has often been the driving force. Similarly, for at least a decade, many of the new aircraft engines have been developed by international consortia.

Similar considerations have led to international sourcing of the design and manufacture of major substructures. Thus, the Japanese industry has become a major supplier to Boeing on its 767 and 777 programs and to Bombardier on its new Global Express and Dash-8 400 aircraft. The Italian, Chinese and Israeli industries have become major suppliers to McDonnell Douglas for its line of commercial transports.

Seeking protection from currency fluctuations may have played a role in recent moves by the Airbus consortium to place more work into North America. Canadair and Messier-Dowty Canada and their North American suppliers have already benefited from these initiatives.

Perhaps the most significant trend in these international collaborations over the next decade is the degree to which they are likely to be employed in the Pacific Rim to bring fresh risk-sharing capital into the aircraft industry. As well, partnerships between western aircraft and aeroengine producers and Eastern European manufacturers are increasing as firms jockey for shares of these formerly closed markets.

With the spectre of continued excess world capacity and energetic new entrants, the aircraft industries of North America and Europe are prime candidates for massive **restructuring and rationalization**. Some significant steps have been taken, for example, by helicopter manufacturers in France and Germany (Eurocopter brought together former Aerospatiale and MBB product lines) and by military aircraft manufacturers in the United States. Further European consolidation of military aircraft production appears inevitable.

**Restructuring in Europe
and North America
gains momentum**

The commuter/regional aircraft segment has also recently seen some consolidation, notably through Bombardier's series of acquisitions over the past decade (Canadair, Short Brothers of Northern Ireland and de Havilland).

During 1995, British Aerospace joined with ATR partners Aerospatiale of France and Alenia of Italy to form a joint marketing and customer support consortium for regional aircraft, called AI(R). British Aerospace simultaneously cancelled further production of its Jetstream 61 turboprop transport. A stated goal of AI(R) is the eventual joint development of new regional aircraft and increased integration of the partner companies. Daimler-Benz Aerospace, Saab, and CASA of Spain have been encouraged to join in order to create a formidable pan-European competitor in the regional aircraft segment.

While there has been some consolidation of ownership among civil aircraft manufacturers, industry rationalization is only in its early stages. McDonnell Douglas, for example, has closed facilities in Ohio and California that previously manufactured subassemblies and components for large commercial transports. Daimler-Benz Aerospace has announced the closure of some of its facilities in Germany. Most significantly, in early 1996, Fokker was sent into bankruptcy and is expected to cease production of new aircraft. Nonetheless, the number of competing producers in several key market segments remains excessive.

Rationalization in the sense of the elimination of product lines is most likely to take place as decisions are made to develop the next generation of aircraft. Given the prominence of aircraft manufacturing in the industrial landscape of the nations involved, few governments will unilaterally abandon the high-value-added employment opportunities provided by aircraft manufacturing. Undoubtedly, for example, the government of the Netherlands agonized over the eventual decision to withdraw further support to Fokker. Future rationalization decisions involving the termination of product lines and plant closures may require direct government-to-government negotiations.

Governments are increasingly attempting to limit their expenditures, and this expenditure is as subject to scrutiny as any other. However, all are sensitive to the key role government support plays in underpinning the competitive position of this strategically important industry. In the United Kingdom, for example, concern has been raised over the risks to the competitive position of British aeronautics firms that reduced government spending will impose if other governments do not reduce support to their respective aeronautics industries. This dilemma is currently being faced by all governments that have historically supported aeronautics R&D, Canada included.

4 GROWTH PROSPECTS

4.1 Strengths and Weaknesses

**Canada is well-positioned
to take advantage
of the current recovery**

The Canadian aircraft industry has performed successfully under the unique and demanding competitive conditions of the global aircraft market. The principal factors underpinning this success remain sound: a continuous investment in the R&D of a diversified array of proprietary products, a civil and export-oriented market focus, close proximity to and integration with U.S. markets and industry, a skilled work force and supportive government programs focussed on product development. As recovery in world aircraft markets continues, these competitive underpinnings are expected to translate into record levels of shipments during 1996. Moderate to strong growth is forecast for most of the markets in which Canada is positioned.

**Uneven ability to
respond to key trends:
some Canadian firms
are vulnerable**

Nonetheless, to sustain competitiveness beyond the current recovery, the Canadian aircraft industry will have to deal with those longer-term trends, outlined in the previous sections, that are sweeping the world industry. The ability to survive increasing cost pressures, new competitors and industry rationalization and to take advantage of new offshore markets will vary by industry tier and by the nature of the activities in which each firm is engaged. All companies, however, will have to improve production efficiencies by instituting new managerial techniques and new ways of organizing production.

**Companies with
proprietary products
and a global focus are
in a stronger position**

Those companies with proprietary products and/or products focussed beyond North American and European markets are in the strongest position to weather these trends. Companies with a simple build-to-print capability and easy-to-acquire manufacturing technologies, dependent on prime and second-tier customers in North America and Europe, are more vulnerable to the change in the world aircraft industry. Companies operating with a cost-plus focus, dependent on military customers, are also vulnerable.

Canada's first-tier producers of complete aircraft, Bombardier and Bell Helicopter, have already begun to respond to world industry trends. To address the increased cost pressures, these firms have begun to implement cost-effective design and production processes as well as better management techniques aimed at improving productivity and lowering the cost of a new aircraft. Bombardier is spreading risk and pursuing new market opportunities by further internationalizing its activities through risk-sharing partnerships with offshore subcontractors.

To have competitive products and to ensure a strong position when negotiating collaborative ventures with their international counterparts, however, Canadian companies need to continuously invest in leading-edge product R&D as well as to aggressively pursue process improvements, work force training and management skills upgrading. Competitors often have some of the costs and risks of product R&D shared by their home governments. Should such support in Canada wane, firms will strive to remain competitive by, among other things, moving more work offshore to take advantage of foreign government support.

World industry trends are even more intense for second-tier Canadian producers. These companies are the first to feel the impact of the efforts by prime manufacturers to contain costs and spread risks. Fewer new aircraft program launches are expected in the future. Canadian second-tier companies will now have to work harder than ever to strategically position themselves on successful programs. Second-tier suppliers are also expected to assume a new, more comprehensive role in aircraft programs. Today, participation in a program requires that second-tier companies become risk-sharing partners and provide prime manufacturers with a complete system solution.

**First- and second-tier
companies are improving
processes, spreading risk**

**Some second-tier
companies without
proprietary product
mandates are vulnerable**

Yet, Canada's mostly foreign-owned, second-tier companies differ in their ability to respond to these new pressures. Some, such as Pratt & Whitney Canada (engines), Messier-Dowty and Menasco (landing gear) have the corporate autonomy and mandate, proprietary product design capability, production technologies and resources that allow them to choose aircraft programs in which to participate and to forge strategic links with producers in emerging aerospace regions. Pratt & Whitney Canada, for example, announced in April 1996 that it would join Snecma, a French aeroengine firm, in the joint development of a new jet engine for 70–100 seat transports. Most of these companies are also implementing more cost-effective design, production and management techniques.

Other plants, those that primarily serve a parent corporation, face a host of emerging competitors with similar capabilities in non-traditional aerospace regions; these competitors are willing to provide risk capital and, in some cases, lower production costs and/or enhanced market access. There is an imminent danger that these companies will lose their production mandates. With their truncated mandates, these companies may be hampered in seeking to diversify and/or to counteract pressure on their parents to provide work packages as an incentive for major aircraft purchases. Smaller second-tier manufacturers may be more challenged to marshal the financial and engineering resources to play the more significant role now being demanded by their customers.

The demands of highly cost-conscious aircraft manufacturers and the impact of new manufacturing competition fall most heavily upon the third-tier aircraft component manufacturers. First- and second-tier customers in the U.S. and Canada are reducing the number of their suppliers, and are demanding continual cost (price) reductions. As well, these traditional customers are beginning to source aircraft and engine components from new lower-cost competitors with equal technological capabilities in eastern Europe and Asia Pacific.

Competition to remain a favoured supplier will be fierce. These small and medium-sized enterprises will have to greatly improve production efficiencies and technology capabilities. Since most of the manufacturing technologies are readily available at the same price to all competitors, the improvements that are needed have less to do with acquiring new capital equipment than with introducing new ways of organizing production and strengthening the management and utilization of available resources, sometimes through a shift in management culture. Differentiation and competitiveness will arise from better management of the human dimension: education, skills, training, flexibility and innovation will win out.

Third-tier companies by definition have little requirement to undertake product R&D. Nevertheless, the ability to progress beyond the simple build-to-print capability and to offer engineering solutions or other value-added activities to the customer will make the third-tier company more attractive as a source of supply. As well, to take advantage of new business opportunities in the more globalized aerospace environment, these companies will have to become more aggressive at exporting their products directly to offshore markets. There

**Third-tier firms are
challenged by Asia Pacific
and eastern Europe**

remain obstacles such as difficulties in financing and adopting the new informatics-oriented production technologies, and in obtaining adequately trained programmers and skilled workers. Shortcomings in their access to market information and in the aggressiveness of their marketing strategies also need to be addressed.

4.2 Key Issues

In assessing the direction ahead, stakeholders must address a number of fundamental issues that bear directly on the medium- and longer-term prospects of the Canadian aircraft industry:

- **The limited opportunities for long-term growth**

There are likely to be relatively few new product launches in the next decade, since most aircraft market segments are already well-served with two or more viable product alternatives. In this environment, potential suppliers are faced with unprecedented pressures: Can they afford *not* to participate in a new program (despite the increased demands of the primes for risk sharing)? Can Canadian suppliers identify those key programs that will be successful, and are they financially and technologically prepared to take advantage of them? Will they be able to displace incumbent suppliers on existing programs?

- **The impact of continued consolidation and rationalization of the world aircraft industry**

As excess production capacity is eventually removed from the world aircraft industry, through the worldwide restructuring and rationalization of the number of competitors and products, are Canada's primes and key second-tier firms well-positioned to survive? In what form?

- **The ability of Canada's major subcomponent manufacturers to continue to compete for major work packages from foreign and Canadian primes**

Canada has large and important subassembly operations that are closely controlled subsidiaries. These plants cannot offer "fresh" capital to their parents, and do not have the autonomy to direct their reinvestment and business development activities.

Other Canadian manufacturers of structural components may be unable either to raise the long-term risk capital being sought by primes, or to handle on their own the increased complexity of many of these work packages. Much of their past work was subcontracted directly by the Canadian primes, who are now "selling" it to their new foreign risk-sharing partners.

These subcomponent manufacturers, however, are often the most important customers for many of Canada's third-tier firms — firms specializing in parts fabrication and subassembly work.

- **The ability of Canadian companies to compete against new low-cost sources of supply**

Primes are continuing to squeeze key suppliers to bring down their costs. Meeting demanding quality and delivery standards will still be the *sine qua non* of participation in the industry. Only suppliers who are able to achieve continuous cost reductions will survive, particularly in the face of new competitors from emerging aerospace nations. What will Canadian companies have to do to meet these pressures?

Industry Canada, jointly with industry and other government partners, is developing strategies to address these competitiveness issues. An example is the Aircraft Manufacturing and R&O Technology Road Map being developed as a pilot program with the Ontario Aerospace Council and Ontario aerospace firms. The objective is to identify technologies that will be required in the development, manufacture and support for the aircraft, aircraft systems and components needed by the industry's customers in the 2001–05 period.

• Penetration of new offshore markets

The output of Canadian subsystems, components and parts suppliers has traditionally been exported, either directly to foreign prime manufacturers, or indirectly as a component in a Canadian-made aircraft or engine. These long-established supply relations, however, now are less important, as primes place major work packages with suppliers throughout the world in order to enhance market access in these areas and in order to draw in new sources of risk-sharing capital. In this changing environment, Canadian parts producers must develop business relationships with these new offshore customers, by improving their market intelligence and skills.

• The level of government support for R&D

Support of the industry's R&D efforts has been one of the three pillars of Canadian government assistance to the aircraft industry (along with enhancing market access and levering military procurements). Government policy instruments in Canada have generally been effective. In the 1990s, in an era of widespread fiscal restraint by governments, budgets for Canadian R&D support programs have declined while the aircraft industry's growth and its investment plans for new product development are expanding. Lowered rates of R&D investment could have a long-term impact on the viability of the Canadian industry. This may in part be offset through risk sharing partnerships and innovation in design and development tools.

What would be Canada's priorities for the limited assistance available?

These issues will be addressed in a forthcoming *Framework for Action*, to be developed after extensive consultations with industry stakeholders. Industry Canada hopes that this *Overview and Prospects* will provide a solid basis for jointly discussing and planning resolutions.

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REFERENCE MATERIALS

The companion paper titled *Canada's Aircraft Industry — Background Analysis* contains a more extensive treatment of the material discussed here, together with extensive historical data on the Canadian industry and a bibliography of valuable research resources. The *Background Analysis* is available at Industry Canada's Internet site:

In English at

http://strategis.ic.gc.ca/sc_indps/sectors/aero/engdoc/sector.html

In French at

http://strategis.ic.gc.ca/sc_indps/sectors/aero/frndoc/stru2.html

